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(54) SOLID-STATE IMAGE-PICKUP DEVICE AND DETECTION OF LIGHT SIGNAL THEREFROM

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a solid-state image-pickup device which can improve spectral sensitivity characteristics and conversion efficiency, and can offer superior linear photoelectric conversion characteristics, by reducing noise caused by surface capture or scattering of light-generated charge.

SOLUTION: Positive holes generated in a well region 15 by light illumination are guided to and embedded into a high-concentration buried layer 25, which has an impurity concentration higher than that of the well region 15, and which is embedded in the vicinity of a source diffused region 16 of an insulated gate type field effect transistor formed within the well region 15. The threshold of the transistor is changed by changing the quantity of the stored holes to detect a change in the threshold as the quantity of received light.

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CLAIMS

[Claim(s)]

[Claim 1] In the solid state image sensor with which two or more arrays of the unit pixel equipped with light-receiving diode and the insulated gate field effect transistor for lightwave signal detection were carried out said light-receiving diode the well of one conductivity type formed in the semi-conductor layer of the opposite conductivity type on the semi-conductor substrate of one conductivity type -- with a field It has the impurity diffusion field of the opposite conductivity type formed in the surface of a field. said well -- said insulated gate field effect transistor said well -- on the surface of a field with said impurity diffusion field and the drain diffusion field of the opposite conductivity type formed in one said well -- with the source diffusion field of the opposite conductivity type which kept said drain diffusion field and spacing in the surface of a field, and was formed in it the

well between said drain diffusion field and said source diffusion field -- with the gate electrode formed through gate dielectric film on the field the well under said gate electrode -- with the channel field where the current carrier of the surface of a field moves and which has the impurity layer of an opposite conductivity type the well under said channel field -- the neighborhood of the source diffusion field in a field -- said well -- the solid state image sensor characterized by having the high concentration buried layer of one conductivity type which has high impurity concentration higher than a field.

[Claim 2] Said high concentration buried layer is a solid state image sensor according to claim 1 characterized by being formed over the channel width direction whole region.

[Claim 3] The neighborhood of said source diffusion field is a solid state image sensor according to claim 1 or 2 characterized by for the direction of channel length from said drain diffusion field to said source diffusion field being a field a part, and being said source diffusion field side.

[Claim 4] said gate electrode -- the shape of a ring -- having -- said source diffusion field -- said well of the center section of said gate electrode -- it is formed in the surface of a field and said drain diffusion field surrounds said gate

electrode -- as -- said well -- it is formed in the surface of a field and said high concentration buried layer surrounds said source diffusion field -- as -- said well -- the solid state image sensor according to claim 1 to 3 characterized by being formed in a field.

[Claim 5] The gate electrode of said insulated gate field effect transistor and its circumference are a solid state image sensor according to claim 1 to 4 characterized by being shaded.

[Claim 6] The solid state image sensor according to claim 1 to 5 characterized by connecting a load circuit to the source diffusion field of said insulated gate field effect transistor, and constituting the source follower circuit.

[Claim 7] The source mode output of said source follower circuit is a solid state image sensor according to claim 6 characterized by connecting with a video-signal output.

[Claim 8] Said unit pixel is a solid state image sensor according to claim 1 to 7 characterized by having stood in a line in a line writing direction and the direction of a train.

[Claim 9] The drain electrical-potential-difference supply line which both the drain diffusion fields of the insulated gate field effect transistor of each of said

unit pixel on a par with said line writing direction are connected, and sends a drain electrical potential difference for said every line, The vertical-scanning signal supply line which both the gate electrodes of the insulated gate field effect transistor of each of said unit pixel on a par with said line writing direction are connected, and tells a vertical-scanning signal for said every line, Two or more perpendicular output lines to which both the source diffusion fields of the insulated gate field effect transistor of each of said unit pixel located in a line in said direction of a train were connected and which were prepared for said every train, The photodetection signal input terminal to which said each perpendicular output line was connected, respectively, and a photodetection signal output terminal, The switch which has a horizontal scanning signal input terminal and was formed for said every train, The common water Hiraide line of force to which both the photodetection signal output terminals of each of said switch were connected, The horizontal scanning signal supply line which tells the horizontal scanning signal which chooses one of said two or more perpendicular output lines to the horizontal scanning signal input terminal of said switch, The drain electrical-potential-difference drive scanning circuit which said drain electrical-potential-difference supply line is connected, and supplies a drain

electrical potential difference alternatively for every line, The vertical-scanning signal drive scanning circuit which said vertical-scanning signal supply line is connected, and supplies a vertical-scanning signal alternatively for every line, The horizontal scanning signal drive scanning circuit which said horizontal scanning signal supply line is connected, and supplies a horizontal scanning signal alternatively for every train, The load circuit which forms a source follower among said one insulated gate field effect transistor which was connected to said water Hiraide line of force, and was chosen by said drive scanning circuit, The solid state image sensor according to claim 8 characterized by having the video-signal output connected to the source mode output of said source follower.

[Claim 10] Said solid state image sensor is a solid state image sensor according to claim 1 to 9 characterized by being formed in said one semi-conductor substrate.

[Claim 11] an optical exposure -- the well of p mold -- the inside of the electron generated in the field, and an electron hole -- this optical generating electron hole -- said well -- it was embedded near the source diffusion field of n mold of the insulated gate field effect transistor formed in the field -- said well -- the lightwave signal detection approach by the solid state image sensor

characterized by changing the threshold of said insulated gate field effect transistor with the amount of the optical generating electron hole which was made to draw and accumulate in the high concentration buried layer of high-concentration p mold rather than a field, and was this accumulated, and detecting the variation of this threshold as light income.

[Claim 12] an optical exposure -- the well of n mold -- the inside of the electron generated in the field, and an electron hole -- this optical generating electron -- said well -- it was embedded near the source diffusion field of p mold of the insulated gate field effect transistor formed in the field -- said well -- the lightwave signal detection approach by the solid state image sensor characterized by changing the threshold of said insulated gate field effect transistor with the amount of the optical generating electron which was made to lead and accumulate in the high concentration buried layer of high-concentration n mold rather than a field, and was this accumulated, and detecting the variation of this threshold as light income.

[Claim 13] In the lightwave signal detection approach by the solid state image sensor according to claim 1 to 10 A field and said high concentration buried layer are p molds. said semi-conductor substrate and said well -- Said semi-conductor

layer, said impurity diffusion field, said drain diffusion field, and said source diffusion field are n molds. An electrical potential difference higher than operating voltage is impressed to said impurity diffusion field, said drain diffusion field, said gate electrode, and said source diffusion field. said well -- the electron hole in a field and said high concentration buried layer to said semi-conductor substrate A pixel is initialized by discharging an electron, respectively to said impurity diffusion field, said drain diffusion field, and said source diffusion field, and depletion-izing it to them. An electron hole and an electron are produced in a field. an optical exposure -- the well of said light-receiving diode -- Operating voltage is impressed to said impurity diffusion field and said drain diffusion field. And an electrical potential difference to which the potential of the gate field of said insulated gate field effect transistor becomes lower than the potential of said light-receiving diode at said gate electrode is impressed. The inside of a field is moved and said optical generating electron hole is stored up in said high concentration buried layer. said optical generating electron hole -- said well -- While forming the reversal field of low electric field in the direction of channel length on said high concentration buried layer which impressed operating voltage to said drain diffusion field and said gate electrode, and said optical

generating electron hole accumulated A high electric-field field is formed in the channel field except said high concentration buried layer top in said direction of channel length. Operating voltage to which said insulated gate field effect transistor operates by the saturation state to said drain diffusion field and said gate electrode is impressed. By having formed said insulated gate field effect transistor in the source follower, and having accumulated said optical generating electron hole in said high concentration buried layer, change of the threshold voltage of said insulated gate field effect transistor The lightwave signal detection approach by the solid state image sensor characterized by detecting a signal by changing into potential change of the source diffusion field of said insulated gate field effect transistor.

[Claim 14] In the lightwave signal detection approach by the solid state image sensor according to claim 1 to 10 A field and said high concentration buried layer are n molds. said semi-conductor substrate and said well -- Said semi-conductor layer, said impurity diffusion field, said drain diffusion field, and said source diffusion field are p molds. The larger electrical potential difference to a negative side than operating voltage is impressed to said impurity diffusion field, said drain diffusion field, said gate electrode, and said source diffusion field. said well

-- the electron in a field and a high concentration buried layer -- said semi-conductor layer -- an electron hole -- said impurity diffusion field -- A pixel is initialized by discharging to said drain diffusion field and said source diffusion field, respectively, and depletion-izing to them. An electron hole and an electron are produced in a field. an optical exposure -- the well of said light-receiving diode -- Operating voltage is impressed to said impurity diffusion field and said drain diffusion field. And an electrical potential difference to which the potential of the gate field of said insulated gate field effect transistor becomes higher than the potential of said light-receiving diode at said gate electrode is impressed. The inside of a field is moved and said optical generating electron is stored up in said high concentration buried layer. said optical generating electron -- said well -- While forming the reversal field of low electric field on said high concentration buried layer which impressed operating voltage to said drain diffusion field and said gate electrode, and said optical generating electron accumulated Form a high electric-field field in the channel field except said high concentration buried layer top, and operating voltage to which said insulated gate field effect transistor operates by the saturation state to said drain diffusion field and said gate electrode is impressed. Change of the threshold voltage of said insulated

gate field effect transistor by having formed said insulated gate field effect transistor in the source follower, and said optical generating electron having been accumulated in said high concentration buried layer The lightwave signal detection approach by the solid state image sensor characterized by detecting a signal by changing into potential change of the source diffusion field of said insulated gate field effect transistor.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the lightwave signal detection approach by the MOS mold solid state image sensor and solid state image sensor of a threshold voltage modulation technique which are used for a video camera, an electronic camera, an image input camera, a scanner, or facsimile in more detail about the lightwave signal detection approach by the solid state image sensor and the solid state image sensor.

[0002]

[Description of the Prior Art] Since semi-conductor image sensors are excellent in mass-production nature, they are applied to almost all images input device equipment with progress of the detailed-ized technique of a pattern. Especially, photosensitivity of CCD (charge-coupled device) is high, and since the noise level is low, it is adopted. [to typical image equipments, such as a video camera and facsimile,] [many]

[0003] However, there are the following problems in CCD (charge-coupled device), and development of the technique which can respond to these problems is desired. That is, since ** power consumption and operating voltage need a complicated manufacturing technology unlike semiconductor devices, such as high ** CMOS device, and ** manufacturing technology with a high production cost differs from semiconductor devices, such as a CMOS device, it is hard making a complicated circumference circuit in CCD.

[0004] In addition to such a situation, the application commercial scene of a solid state image sensor is expanded, and an MOS mold solid state image sensor is improved increasingly in recent years. Moreover, it is becoming possible to create the device below submicron one with a semi-conductor detailed-ized technique. On the other hand, about the property of the body of image sensors, the engine-performance difference of MOS mold image sensors and CCD series was large, especially, in MOS mold image sensors, the improvement of a random noise property and a fixed noise property is needed, and fundamental improvement in the engine performance was desired.

[0005] On the other hand, the amplifying circuit which can localize the photo-electric-conversion section by advance of a micro-lens technique, and

consists of two to 3 transistor for every pixel with a detailed-ized technique can be accumulated now, and improvement in sensibility was able to be aimed at. For this reason, it became possible to reduce in circuit the fixed pattern noise made by X, the thermal noise (kTC noise) generated in the one MOS switch section among two of Y, or component dispersion to some extent.

[0006] From such a point, the so-called active CMOS image sensors in which the detailed transistor amplifying circuit by the CMOS technology was formed in the pixel of a light-receiving device attract attention. Since active CMOS image sensors do not need a special manufacturing technology except the usual CMOS technology, it is easy to integrate them for the same chip as a part for a light sensing portion, and they can manufacture a CMOS circumference circuit cheaply. Moreover, it has the features that power consumption and operating voltage are small.

[0007] For this reason, it is expected very much towards implementation of the one chip camera which carried the complicated digital disposal circuit in the future. The following examples are given as an advanced type of an active CMOS image-sensors component. That is, the CMD (Charge Modulation Device: charge modulation element) mold solid state image sensor is opened to

JP,60-140752,A, JP,60-206063,A, JP,6-120473,A, etc. This component is a component which adopted the CCD-description in optoelectric-transducer structure, and in order to raise a numerical aperture, it makes the gate electrode of an MOS transistor photograph gate electrode structure. The charge generated by optical pumping is stored up in the gate oxide under the photograph gate electrode of an MOS transistor, and the interface of Si layer, and current control is performed. Since **** of a charge is performed in the perfect depletion-ized mode, the thermal-noise property of a transistor is improvable.

[0008] Moreover, the BCMD (Bulk Charge Modulated Device) mold solid state image sensor is opened to JP,64-14959,A etc. As shown in drawing 13 (a), in order that this component might also raise a numerical aperture, the gate electrode 7 of an MOS transistor was made into photograph gate electrode structure, and the accumulation layer 3 of an optical generating charge is formed on the N layer 2 under the photograph gate electrode 7. In this case, the accumulation layer 3 of an optical generating charge was established in the substrate 1 side rather than the channel field of photograph gate electrode 7 directly under, it controlled that a trap was carried out to the interface of the gate oxide 6 to which an optical generating charge touches the N layer 9 under the

photograph gate electrode 7, and the noise resulting from it is controlled. In addition, for a sign 2, as for a source diffusion field and 5, N layer and 4 are [a drain diffusion field and 8] constant current power supplies among drawing 13 (a).

[0009] Furthermore, the solid state image sensor of a threshold voltage modulation technique is opened to JP,2-304973,A. In this component, it has ring-gate electrode structure and a source diffusion field is formed in the center section of ring-gate electrode structure, and the drain diffusion field is formed so that a ring-gate electrode may be surrounded. In this case, the drain diffusion field serves as the high concentration impurity diffused layer of a pad photodiode. the well under having prepared the light sensing portion out of the transistor field, and the channel width field of a part of channel width direction -- it is characterized by preparing the low place of potential one place to a signal charge ranging from the source diffusion field to a drain diffusion field in a field.

[0010] Light is irradiated at a pad photodiode, a charge is generated, and a threshold is controlled by this component by are recording of the optical generating charge to a pad photodiode using the substrate bias effectiveness. Especially, it is the optical exposure of feeble reinforcement, when there are few

optical generating charges, it is effective, and an optical generating charge is brought together in the low place of potential to a signal charge, the ununiformity of sensibility is suppressed, and control of a fixed pattern noise is aimed at.

[0011]

[Problem(s) to be Solved by the Invention] However, in a CMD mold solid state image sensor, since the charge used for photo electric conversion exists near a semi-conductor front face, the random noise component by charge capture or dispersion in a front face has the problem that it cannot remove. In a BCMD mold solid state image sensor, since the charge accumulation layer 3 exists throughout the channel field under the photograph gate electrode 7 as shown in drawing 13 (a), it will be difficult to fully saturate a transistor, and as shown in drawing 13 (b), the current-voltage characteristic will turn into a triode area property. For this reason, there is a problem that sufficient linearity is not acquired when transforming an optical generating charge into an electrical potential difference by the source follower.

[0012] Moreover, deficiently in the linearity of the potential modulation to the amount of impregnation charges, since it is scattered to the whole channel field under the photograph gate electrode 7 and the whole channel field contributes to

a current modulation, since the charge detection capacity of carrier distribution in the charge accumulation layer 3 is also comparatively large, it has the problem that conversion efficiency is also inferior. Furthermore, a CMD mold and a BCMD mold solid state image sensor have the problem of degradation of the spectral sensitivity characteristic by multiplex interference of the incident light of the metal-oxide-semiconductor structure proper of a light sensing portion in common with photograph gate electrode structure.

[0013] Furthermore, with photograph gate electrode structure, there is also a problem that special and complicated manufacture processes -- formation of the photograph gate electrode which consists of thin polish recon film which has translucency is needed -- are required on a production process. the well under some channel-width fields -- the place the potential is low in a place in the solid state image sensor which prepared the low place of potential one place to the signal charge inside -- the well under some channel-width fields -- it is in a field, and since it has prepared ranging from the source diffusion field to a drain diffusion field, the current-voltage characteristic turns into the property of a triode field, and there is a problem that where of sufficient linearity is not acquired when transforming an optical generating charge into an electrical potential difference

by the source follower.

[0014] It aims at offering the photodetection approach by the solid state image sensor and solid state image sensor which can acquire the photoelectric transfer characteristic excellent in linearity, and can create a light sensing portion using the same manufacturing technology as the manufacturing technology of CMOS while this invention is made in view of an above-mentioned situation, reduces the noise resulting from surface capture or dispersion of an optical generating charge and aims at improvement in the spectral sensitivity characteristic or conversion efficiency.

[0015]

[Means for Solving the Problem] In the solid state image sensor with which two or more arrays of the unit pixel which invention of claim 1 required for the solid state image sensor, and was equipped with light-receiving diode and the insulated gate field effect transistor for lightwave signal detection in order to attain the above-mentioned purpose were carried out the well of one conductivity type with which said light-receiving diode was formed in the semi-conductor layer of the opposite conductivity type on the semi-conductor substrate of one conductivity type -- with a field It has the impurity diffusion field of the opposite

conductivity type formed in the surface of a field. said well -- said insulated gate field effect transistor said well -- on the surface of a field with said impurity diffusion field and the drain diffusion field of the opposite conductivity type formed in one said well -- with the source diffusion field of the opposite conductivity type which kept said drain diffusion field and spacing in the surface of a field, and was formed in it the well between said drain diffusion field and said source diffusion field -- with the gate electrode formed through gate dielectric film on the field the well under said gate electrode -- with the channel field where the current carrier of the surface of a field moves and which has the impurity layer of an opposite conductivity type the well under said channel field -- the neighborhood of the source diffusion field in a field -- said well -- it is characterized by having the high concentration buried layer of one conductivity type which has high impurity concentration higher than a field.

[0016] Invention of claim 2 relates to a solid state image sensor according to claim 1, and said high concentration buried layer is characterized by being formed over the channel width direction whole region. Invention of claim 3 relates to a solid state image sensor according to claim 1 or 2, the direction of channel length from said drain diffusion field to said source diffusion field is a

field a part, and the neighborhood of said source diffusion field is characterized by being said source diffusion field side.

[0017] Invention of claim 4 relates to a solid state image sensor according to claim 1 to 3. It is formed in the surface of a field. said gate electrode -- the shape of a ring -- having -- said source diffusion field -- said well of the center section of said gate electrode -- said drain diffusion field surrounds said gate electrode -- as -- said well -- it is formed in the surface of a field and said high concentration buried layer surrounds said source diffusion field -- as -- said well -- it is characterized by being formed in a field.

[0018] Invention of claim 5 relates to a solid state image sensor according to claim 1 to 4, and it is characterized by shading the gate electrode of said insulated gate field effect transistor, and its circumference. Invention of claim 6 is characterized by starting a solid state image sensor according to claim 1 to 5, connecting a load circuit to the source diffusion field of said insulated gate field effect transistor, and constituting the source follower circuit.

[0019] Invention of claim 7 relates to a solid state image sensor according to claim 6, and it is characterized by connecting the source mode output of said source follower circuit to a video-signal output. Invention of claim 8 relates to a

solid state image sensor according to claim 1 to 7, and it is characterized by having located said unit pixel in a line in a line writing direction and the direction of a train. Invention of claim 9 relates to a solid state image sensor according to claim 8, and both the drain diffusion fields of the insulated gate field effect transistor of each of said unit pixel on a par with said line writing direction are connected. The drain electrical-potential-difference supply line which sends a drain electrical potential difference for every Noriyuki Saki, and the vertical-scanning signal supply line which both the gate electrodes of the insulated gate field effect transistor of each of said unit pixel on a par with said line writing direction are connected, and tells a vertical-scanning signal for said every line, Two or more perpendicular output lines to which both the source diffusion fields of the insulated gate field effect transistor of each of said unit pixel located in a line in said direction of a train were connected and which were prepared for said every train, The photodetection signal input terminal to which said each perpendicular output line was connected, respectively, and a photodetection signal output terminal, The switch which has a horizontal scanning signal input terminal and was formed for said every train, Common water Hiraide line of force to which both the photodetection signal output

terminals of each of said switch were connected, The horizontal scanning signal supply line which tells the horizontal scanning signal which chooses one of said two or more perpendicular output lines to the horizontal scanning signal input terminal of said switch, The drain electrical-potential-difference drive scanning circuit which said drain electrical-potential-difference supply line is connected, and supplies a drain electrical potential difference alternatively for every line, The vertical-scanning signal drive scanning circuit which said vertical-scanning signal supply line is connected, and supplies a vertical-scanning signal alternatively for every line, The horizontal scanning signal drive scanning circuit which said horizontal scanning signal supply line is connected, and supplies a horizontal scanning signal alternatively for every train, It is characterized by having the video-signal output which was connected to said water Hiraide line of force, and was connected to the load circuit which forms a source follower among said one insulated gate field effect transistor chosen by said drive scanning circuit, and the source mode output of said source follower.

[0020] Invention of claim 10 relates to a solid state image sensor according to claim 1 to 9, and it is characterized by forming said solid state image sensor in said one semi-conductor substrate. the lightwave signal detection approach

according [invention of claim 11] to a solid state image sensor -- starting -- an optical exposure -- the well of p mold -- the inside of the electron generated in the field, and an electron hole -- this optical generating electron hole -- said well -- it was embedded near the source diffusion field of n mold of the insulated gate field effect transistor formed in the field -- said well -- the threshold of said insulated gate field effect transistor is changed with the amount of the optical generating electron hole which was made to draw and accumulate in the high concentration buried layer of high-concentration p mold rather than a field, and was this accumulated, and it is characterized by detecting the variation of this threshold as light income.

[0021] the lightwave signal detection approach according [invention of claim 12] to a solid state image sensor -- starting -- an optical exposure -- the well of n mold -- the inside of the electron generated in the field, and an electron hole -- this optical generating electron -- said well -- it was embedded near the source diffusion field of p mold of the insulated gate field effect transistor formed in the field -- said well -- the threshold of said insulated gate field effect transistor is changed with the amount of the optical generating electron which was made to lead and accumulate in the high concentration buried layer of high-concentration

n mold rather than a field, and was this accumulated, and it is characterized by detecting the variation of this threshold as light income.

[0022] In the lightwave signal detection approach invention of claim 13 relates to the lightwave signal detection approach by the solid state image sensor, and according to a solid state image sensor according to claim 1 to 10 A field and said high concentration buried layer are p molds. said semi-conductor substrate and said well -- Said semi-conductor layer, said impurity diffusion field, said drain diffusion field, and said source diffusion field are n molds. An electrical potential difference higher than operating voltage is impressed to said impurity diffusion field, said drain diffusion field, said gate electrode, and said source diffusion field. said well -- the electron hole in a field and a high concentration buried layer -- said semi-conductor substrate -- an electron -- said impurity diffusion field -- A pixel is initialized by discharging to said drain diffusion field and said source diffusion field, respectively, and depletion-izing to them. An electron hole and an electron are produced in a field. an optical exposure -- the well of said light-receiving diode -- Operating voltage is impressed to said impurity diffusion field and said drain diffusion field. And an electrical potential difference to which the potential of the gate field of said insulated gate field effect transistor

becomes lower than the potential of said light-receiving diode at said gate electrode is impressed. The inside of a field is moved and said optical generating electron hole is stored up in said high concentration buried layer. said optical generating electron hole -- said well -- While forming the reversal field of low electric field in the direction of channel length on said high concentration buried layer which impressed operating voltage to said drain diffusion field and said gate electrode, and said optical generating electron hole accumulated A high electric-field field is formed in the channel field except said high concentration buried layer top in said direction of channel length. Operating voltage to which said insulated gate field effect transistor operates by the saturation state to said drain diffusion field and said gate electrode is impressed. By having formed said insulated gate field effect transistor in the source follower, and having accumulated said optical generating electron hole in said high concentration buried layer, change of the threshold voltage of said insulated gate field effect transistor It is characterized by detecting a signal by changing into potential change of the source diffusion field of said insulated gate field effect transistor.

[0023] In the lightwave signal detection approach invention of claim 14 relates to the lightwave signal detection approach by the solid state image sensor, and

according to a solid state image sensor according to claim 1 to 10 A field and said high concentration buried layer are n molds. said semi-conductor substrate and said well -- Said semi-conductor layer, said impurity diffusion field, said drain diffusion field, and said source diffusion field are p molds. The larger electrical potential difference to a negative side than operating voltage is impressed to said impurity diffusion field, said drain diffusion field, said gate electrode, and said source diffusion field. said well -- the electron in a field and a high concentration buried layer -- said semi-conductor layer -- an electron hole -- said impurity diffusion field -- A pixel is initialized by discharging to said drain diffusion field and said source diffusion field, respectively, and depletion-izing to them. An electron hole and an electron are produced in a field. an optical exposure -- the well of said light-receiving diode -- Operating voltage is impressed to said impurity diffusion field and said drain diffusion field. And an electrical potential difference to which the potential of the gate field of said insulated gate field effect transistor becomes higher than the potential of said light-receiving diode at said gate electrode is impressed. The inside of a field is moved and said optical generating electron is stored up in said high concentration buried layer. said optical generating electron -- said well -- While forming the reversal field of low

electric field on said high concentration buried layer which impressed operating voltage to said drain diffusion field and said gate electrode, and said optical generating electron accumulated Form a high electric-field field in the channel field except said high concentration buried layer top, and operating voltage to which said insulated gate field effect transistor operates by the saturation state to said drain diffusion field and said gate electrode is impressed. Change of the threshold voltage of said insulated gate field effect transistor by having formed said insulated gate field effect transistor in the source follower, and said optical generating electron having been accumulated in said high concentration buried layer It is characterized by detecting a signal by changing into potential change of the source diffusion field of said insulated gate field effect transistor.

[0024] this invention -- setting -- the well under a channel field -- a part of direction of channel length which is in a field and results near a source diffusion field for example, from a drain diffusion field to a source diffusion field -- a field -- it is -- a source diffusion field side -- and a part of cross direction of a channel field -- or the crosswise whole -- crossing -- a well -- the one same conductivity type as a field -- having -- and a well -- the high concentration buried layer (carrier pocket) which has high impurity concentration higher than a field is

prepared.

[0025] for example, the case where a ring-like gate electrode is used -- the well of the center section of the gate electrode -- a source diffusion field is formed in the surface of a field, and a gate electrode is surrounded -- as -- a well -- a drain diffusion field is formed in the surface of a field, and a source diffusion field is surrounded -- as -- a well -- a high concentration buried layer is formed in a field. such a configuration -- the well of p mold -- the case of the high concentration buried layer of p mold in a field -- the high concentration buried layer of p mold -- by the way, potential becomes the lowest to an electron hole. or the well of n mold -- the case of the high concentration buried layer of n mold in a field -- the high concentration buried layer of n mold -- by the way, potential becomes the highest to an electron.

[0026] furthermore, a well -- the field is formed in common by light-receiving diode and the field-effect transistor in [the impurity diffusion field of light-receiving diode, and the drain diffusion field of a field-effect transistor] one. Moreover, the high concentration buried layer is prepared near the source diffusion field. since the high concentration buried layer is arranged near the source diffusion field -- the well of a light-receiving diode part -- it is easy to bring

the optical generating charge generated in the field in a high concentration buried layer together.

[0027] namely, the well of p mold -- when a detection transistor is set to nMOS, using a field, the potential in the direction of a source diffusion field is low set up rather than a drain diffusion field using an electron hole among optical generating charges. or the well of n mold -- when a detection transistor is set to pMOS, using a field, the potential in the direction of a source diffusion field is highly set up rather than a drain diffusion field using an electron among optical generating charges. For example, when the forward or negative operating voltage VDD is impressed to a drain diffusion field and a low electrical potential difference is impressed to a gate electrode, electric field by which an optical generating charge goes to the direction of the drain diffusion field of a field-effect transistor, i.e., an impurity diffusion field, to the source diffusion field of light-receiving diode arise.

[0028] therefore, the optical generating charge which read-out finished by initialization and a well -- the time of impressing an electrical potential difference as mentioned above, after discharging residual charge, such as an electron hole which carbonates the acceptor in a field etc., out of a semi-conductor substrate

-- the well of a light-receiving diode part -- the optical generating charge generated in the field moves to the direction of a high concentration buried layer, and is accumulated in a high concentration buried layer. since it is the low potential there and it becomes impossible to escape easily once optical generating charges gather for a high concentration buried layer -- a well -- diffusion of the optical generating charge in a field can be prevented, and an optical generating charge can be efficiently accumulated in a high concentration buried layer.

[0029] In addition, when the optical generating charge accumulated in the high concentration buried layer also impresses a larger electrical potential difference than operating voltage to a gate electrode, a drain diffusion field, and a source diffusion field and raises electric field, it can eliminate. If an optical generating charge is accumulated into a high concentration buried layer, a Fermi level changes according to an accumulated dose, and space charge will bring about the fall of the threshold voltage of a transistor in order to decrease in number. A reversal field is formed on a high concentration buried layer of the conservation of charge at coincidence, the carrier of a conductivity type contrary to the optical generating charge accumulated into the high concentration buried layer in the

reversal field increases, and channel conductance increases.

[0030] since potential is high in fields other than a high concentration buried layer and an optical generating charge is not accumulated on the other hand -- wells other than on a high concentration buried layer -- a reversal field will not be generated in a field front face, but a high electric-field field will be generated. Thus, when a reversal field and a high electric-field field are generated to one channel field, a transistor comes to operate by the saturation state. Therefore, if the gate voltage to which a transistor can operate is impressed to gate voltage, the transistor by which wiring connection was made as a source follower will follow in footsteps of threshold voltage, and will change source potential.

[0031] And since a transistor operates by the saturation state, a current is decided only by the potential difference between the gate-sources. For this reason, change of source potential is decided only by the accumulated dose of an optical generating charge. Therefore, it becomes possible by outputting this source potential as a video signal to perform photo electric conversion with sufficient linearity.

[0032] Moreover, since a fluctuated part of the accumulated dose of an optical generating charge and the charge of a reversal field is balanced, the

accumulated dose of an optical generating charge is equivalent to the charge to gate-dielectric-film capacity, and a changed part of threshold voltage is outputted. Here, since the charge to gate-dielectric-film capacity is limited to the gate-dielectric-film capacity on the high concentration buried layer as a carrier pocket, it can determine detection sensitivity with the area and the depth of oxide-film thickness and a high concentration buried layer. And since it can consider that most of this detection capacity is fixed capacity, the high sensitivity detection which was extremely excellent in the linearity of the transfer characteristics of charge-electrical-potential-difference conversion is attained.

[0033] Furthermore, when the front face of a transistor has DEPURESHON-ized, an obstruction will exist to a hole. Since the front face is filled with the photograph gate electrode structure where it is used by other methods by the optical generating charge, at this time, a front face is equilibrated and dark current generating by thermal excitation and the potential modulation by the parasitism hole storage pose a problem.

[0034] On the other hand, in this invention, the channel field of a transistor sweeps out residual charge (initialization), and a depletion condition is held behind. And since the transistor field is shaded, it does not come to form a

superfluous carrier layer. Therefore, the carrier temporarily captured on the front face does not overcome an obstruction, either, carries out it, and it does not serve as the dark current, and a noise component can be controlled from a front face.

[0035] as mentioned above, the well under the isolated channel field which interacts with neither of the semi-conductor layer surface parts the optical generating charge which should control a current -- field HE impregnation is carried out and the potential barrier near a source diffusion field is changed. That is, by collecting optical generating charges near the source diffusion field, by considering as structure which controls the threshold voltage of a transistor, it cannot have a noise component but the ideal threshold voltage modulation-technique CMOS image-sensors component in which high sensitivity detection is possible can be offered with sufficient linearity.

[0036]

[Embodiment of the Invention] Below, the gestalt of operation of this invention is explained, referring to a drawing. Drawing 1 is the top view showing the component layout in the unit pixel of the CMOS image sensors concerning the gestalt of operation of this invention. As shown in drawing 1 , the light-receiving

diode 111 and MOS transistor 112 for lightwave signal detection are adjoined and formed in the unit pixel 101. these -- one well -- the field 15 is shared. namely, the well of the light-receiving diode 111 -- the generating field of the charge according [a field 15] to an optical exposure -- constituting -- the well of MOS transistor 112 for lightwave signal detection -- the field 15 constitutes the gate field.

[0037] the impurity diffusion field 17 of the light-receiving diode 111, and drain diffusion field 17a of MOS transistor 112 for lightwave signal detection -- a well -- it is formed in the surface of a field 15 in one. Drain diffusion field 17a is formed so that the periphery section of the ring-like gate electrode 19 may be surrounded, and the source diffusion field 16 is formed in the core of the ring-like gate electrode 19. the well under the gate electrode 19 -- it is in a field 15, and the carrier pocket (high concentration buried layer) 25 is formed so that the source diffusion field 16 may be surrounded in the periphery of the source diffusion field 16.

[0038] in addition, the time of actuation of MOS transistor 112 for lightwave signal detection -- the well under the gate electrode 19 -- n mold impurity layer (impurity layer of an opposite conductivity type) which introduced the impurity of

n mold is formed in the channel field so that the channel field of the front face of a field 15 may maintain a reversal condition or a DEPURESHON condition. Drain diffusion field 17a is connected with the drain electrical-potential-difference (VDD) supply line 22, the gate electrode 19 is connected to the vertical-scanning signal (VSCAN) supply line 21, and the source diffusion field 16 is connected to the perpendicular output line 20.

[0039] Moreover, fields other than light-receiving aperture 24 of the light-receiving diode 111 are shaded by the metal layer (light-shielding film) 23. Next, the device structure of the CMOS image sensors concerning the gestalt of operation of this invention is explained using a sectional view. Drawing on drawing 2 is a sectional view showing the device structure of the CMOS image sensors concerning the gestalt of operation of this invention equivalent to the A-A line sectional view of drawing 1 . Drawing under drawing 2 is a potential Fig. along a semi-conductor substrate front face.

[0040] drawing on drawing 3 -- the well under a channel field -- it is the sectional view showing near the carrier pocket 25 in a field 15 in a detail. Moreover, drawing under drawing 3 is a potential Fig. which meets the F-F line in a field parallel to the semi-conductor substrate front face containing the carrier pocket

25 when the optical generating hole is accumulated in the carrier pocket 25, i.e., drawing. However, distribution of the electron of the reversal field of the channel field on the carrier pocket 25 is indicated to the same Fig.

[0041] Drawing 4 is the B-B line sectional view of drawing 1 , and drawing 5 is the C-C line sectional view of drawing 1 . As shown in drawing on drawing 2 , on the substrate 11 which consists of p-type silicon, n mold silicon is grown epitaxially and an epitaxial layer (n type layer) 12 is formed. The above constitutes a semi-conductor substrate. The well field 15 of p mold is formed in this n type layer 12. In addition, the field insulator layer 14 and the component isolation diffusion field 13 under it are formed so that each unit pixel may be separated between the adjoining unit pixels.

[0042] Next, drawing 2 and drawing 4 explain the detail of the light-receiving diode 111. That is, it consists of a well field 15 and an impurity diffusion field 17 formed in the surface of n type layer 12 so that most fields might start the well field 15. That is, it is having the embedded structure to an electron hole (hole). It connects with the drain electrical-potential-difference (VDD) supply line 22, and bias of the impurity diffusion field 17 is carried out to electropositive potential. Thereby, in order for the hole generated by incident light to exist in the well field

15 under the impurity diffusion field 17, it is not influenced by the semi-conductor layer front face with many interface trapping levels, but can aim at reduction of a noise.

[0043] Next, drawing 2 and drawing 5 explain the detail of MOS transistor (nMOS) 112 for lightwave signal detection. That is, the ring-like gate electrode 19 is n+. The impurity diffusion field 17 of a mold, and n+ formed in one It has the structure surrounded by drain diffusion field 17a of a mold. It is n+ to the center section of the ring-like gate electrode 19. The source diffusion field 16 of a mold is formed. and the well between drain diffusion field 17a and the source diffusion field 16 -- the gate electrode 19 is formed through gate dielectric film 18 on the field 15. the well under the gate electrode 19 -- the surface of a field 15 serves as a channel field.

[0044] moreover, the well under a channel field -- in a field 15, the direction of channel length is the periphery of a field 16, i.e., a source diffusion field, a part, and the source diffusion field 16 is surrounded -- as -- p+ The carrier pocket 25 of a mold is formed. This p+ The carrier pocket 25 of a mold can be formed with ion-implantation. the well below the channel field which produces the carrier pocket 25 on a front face -- it is formed in a field 15. As for the carrier pocket 25,

forming so that a channel field may not be started is desirable. Furthermore, in a normal operation electrical potential difference, in order to hold a channel field in a reversal condition or the DEPURESHON condition, it is required to introduce n mold impurity of the suitable concentration for a channel field, and to form n mold impurity layer 15a.

[0045] Above-mentioned p+ In the carrier pocket 25 of a mold, since the potential over an optical generating hole becomes low among optical generating charges, when the high voltage is impressed to drain diffusion field 17a, optical generating holes gather for this carrier pocket 25. Drawing shows the condition that the optical generating hole is accumulated in the carrier pocket 25. An optical generating hole is accumulated in the carrier pocket 25 at the following figure of drawing 2 , and the potential Fig. in the condition that induction of the electron was carried out to the channel field, and the reversal field is generated is shown. moreover, the well under a channel field -- the component structure section of a near [the carrier pocket 25 in a field 15] and the detail of a potential Fig. are shown in drawing 3 .

[0046] Next, with reference to drawing 6 (a) and (b), the configuration of the whole CMOS image sensors using the unit pixel of the above-mentioned

structure is explained. Drawing 6 (a) shows the circuitry Fig. of the CMOS image sensors in the gestalt of operation of this invention. As shown in drawing 6 (a), these CMOS image sensors have taken the configuration of a two-dimensional array sensor, and they are arranged so that the unit pixel of the above-mentioned structure may be located in a line with the direction of a train, and a line writing direction in the shape of a matrix.

[0047] Moreover, the drive scanning circuit 102 of a vertical-scanning signal (VSCAN) and the drive scanning circuit 103 of a drain electrical potential difference (VDD) are arranged across the pixel field at the right and left. the drain electrical-potential-difference supply lines 22a and 22b which have come out from the drive scanning circuit 103 of a drain electrical potential difference (VDD) for every line are connected to every one drain of MOS transistor 112 in all the unit pixels 101 located in a line with a line writing direction for every line, respectively. furthermore, the vertical-scanning signal supply lines 21a and 21b which have come out from the drive scanning circuit 102 of a vertical-scanning signal (VSCAN) to every one gate of MOS transistor 112 in all the unit pixels 101 located in a line with a line writing direction for every line for every line are connected, respectively.

[0048] Moreover, the source of MOS transistor 112 in all the unit pixels 101 located in a line in the direction of a train for every train is connected to different perpendicular output lines 20a and 20b for every train. Each perpendicular output lines 20a and 20b are connected to every one drains (photodetection signal input terminal) 28a and 29a of MOS transistors 105a and 105b as a different switch for every train. The gates (horizontal scanning signal input terminal) 28b and 29b of each switches 105a and 105b are connected to the drive scanning circuit 104 of a horizontal scanning signal (HSCAN).

[0049] Moreover, the sources (photodetection signal output terminal) 28c and 29c of each switches 105a and 105b are connected to the video-signal output 107 through the common constant current source 106. That is, it connects with a constant current source 106, and the source of MOS transistor 112 in each unit pixel 101 forms the source follower circuit of a pixel unit. Therefore, the potential difference between the gate-sources of each MOS transistor 112 and the potential difference between the bulk-sources are determined by the connected constant current source (load circuit) 106.

[0050] The video signal (Vout) which drove MOS transistor 112 of sequential ** each unit pixel, and is proportional to the amount of incidence of light with a

vertical-scanning signal (VSCAN) and a horizontal scanning signal (HSCAN) is read. As mentioned above, since the unit pixel 101 consists of light-receiving diode 111 and MOS transistor 112, the part of a pixel can be created using a CMOS technology. Therefore, all of a part for the above-mentioned picture element part, and the drive scanning circuits 102-104 and a constant current source 106 grade circumference circuit can be created to the same semi-conductor substrate.

[0051] Drawing 6 (b) shows the timing chart of each I/O signal for operating the CMOS image sensors concerning this invention. the well of p mold -- using a field 15, when the transistor 112 for lightwave signal detection is nMOS, it applies. Component actuation is a **** period (initialization)-are recording period-read-out period-**** period (initialization). - It carries out repeatedly like ..

[0052] this time -- actuation of a solid state image sensor -- following -- the well of the unit pixel 101 -- signs that the potential in a field 15 changes are also explained to coincidence, referring to drawing 7 , drawing 8 , and the potential Fig. of drawing 9 . Furthermore, it explains to coincidence, referring to the graph shown in drawing 10 about the current-voltage characteristic of MOS transistor 112 for lightwave signal detection in the unit pixel 101.

[0053] In drawing 7 thru/or drawing 9 , an axis of ordinate expresses potential and an axis of abscissa expresses the depth from a substrate front face. Moreover, drawing 7 (a), drawing 8 (a), and drawing 9 (a) express the potential distribution in D-D line cross section of drawing 4 in a **** period (initialization), an are recording period, and a read-out period, respectively. Furthermore, drawing 7 (b), drawing 8 (b), and drawing 9 (b) express the potential distribution in the E-E line cross section of drawing 5 in a **** period (initialization), an are recording period, and a read-out period, respectively.

[0054] First, a **** period is a period which discharges residual charge of read-out Saki of a lightwave signal, such as an electron hole, an electron, etc. which carbonate an optical generating charge, an acceptor, a donor, etc. whom read-out finished, or are captured by surface level, out of a semi-conductor, before accumulating an optical generating charge (hole). That is, this actuation is called substrate **** actuation (initialization actuation) of an optical generating charge, and it is carried out per line.

[0055] Initialization actuation is performed for making the carrier pocket 25 the next are recording period in the sky, and accumulating a new optical generating charge. That is, it is for taking out only the accumulated optical generating

charge as a video signal, and preventing the noise by residual charge. In this case, a larger electrical potential difference than the usual operating voltage is impressed to drain diffusion field 17a, the gate electrode 19, and the source diffusion field 16. That is, the electrical potential difference of abbreviation +5V is supplied to the VDD supply lines 22a and 22b, it is impressed by drain diffusion field 17a, the electrical potential difference of abbreviation +5V is supplied to the VSCAN supply lines 21a and 21b, and it is impressed by the gate electrode 19. Moreover, since a channel field flows by impressing the electrical potential difference of abbreviation +5V to the gate electrode 19, the electrical potential difference of abbreviation +5V impressed to drain diffusion field 17a is impressed to the source diffusion field 16 as it is.

[0056] As shown in drawing 7 (a) and (b), the reverse bias of the pn junction is carried out, the electric field in the well field 15 let N field and P field pass, and this electrical-potential-difference impression is p+. It is made suitable in the substrate 11 direction of a mold. thereby -- a well -- a field 15 -- the hole which remains in a semi-conductor in addition to this -- p+ It is discharged by the substrate 11 of a mold and an electron is discharged from the source diffusion field 16 or the drain diffusion field 17. Although a transistor cannot make an

optical generating charge discharge from the carrier pocket 25 on the gate voltage and the drain electrical potential difference which can operate by the saturation state when the optical generating charge is especially accumulated in the carrier pocket 25, an optical generating charge can be made to discharge from the carrier pocket 25 by impressing about [5V] still higher gate voltage and a drain electrical potential difference.

[0057] Ushiro by whom residual charge was discharged -- a well -- a field 15 is in the condition of having depletion-ized. Since initialization which was described above does not produce residual charge, the thermal noise (kTC noise) by the thermal fluctuation of a carrier does not occur, but it is ideal. In addition, in this initialization actuation, since there is no current pass, the booster circuit carried on chip can use it easily.

[0058] next, an are recording period generates an optical generating charge by optical exposure -- making -- the optical generating charge -- the well under a channel field -- it is the period stored up in the carrier pocket 25 in a field 15. In addition, in this are recording period, the electronic shutter actuation by the horizontal scanning time basis is also possible. about [in this case, / to which it lets the VDD supply lines 22a and 22b pass, and an MOS transistor can operate

before an optical exposure to the drain diffusion field 17 of MOS transistor 112 in all the unit pixels 101] -- while impressing the electrical potential difference which is about +2-3V, it lets the VSCAN supply lines 21a and 21b pass, and a low electrical potential difference to which an MOS transistor maintains a cut-off condition to the gate of MOS transistor 112 for every train is impressed. Thus, are recording of an optical generating charge is performed for every sensor train arranged on each horizontal scanning signal line.

[0059] By the electrical-potential-difference impression to drain diffusion field 17a, the majority carrier in the well field 15 of p mold (electron hole) is p+. Since it is swept out at the substrate 11 side of a mold, the inside of the well field 15 is depletion-ized, and the negative space charge layer which consists of an acceptor exists. if light is irradiated to a pixel field in this condition -- the well of the light-receiving diode 111 -- an electronic-electron hole pair occurs to a field 15.

[0060] Here, since the gate voltage of MOS transistor 112 is set up low, an optical generating electron is discharged by the drain electrical potential difference from the drain diffusion field 17 among optical generating charges. On the other hand, the low potential of the source diffusion field 16 lengthens, it

moves to the direction of the source diffusion field 16, and an optical generating hole is accumulated in the carrier pocket 25 which is the lowest [potential]. This condition is shown in drawing 8 (a) and (b).

[0061] migration of the optical generating hole in an are recording period -- the well of p mold -- since it is carried out only in a field 15, on the occasion of migration of an optical generating hole, it is not influenced of a semi-conductor front face, and a noise component is not generated. By the way, when the front face of a transistor has DEPURESHON-ized, an obstruction will exist to a hole.

[0062] Since the front face is filled with the photograph gate electrode structure where it is used by other methods by the optical generating charge as shown in drawing 11 (c), a front face is equilibrated and dark current generating by thermal excitation and the potential modulation by the parasitism hole storage pose a problem. On the other hand, in the gestalt of this operation, as the channel field of a transistor is shown in drawing 11 (a), a depletion condition is held after initialization. And since the gate of a transistor and its circumference are shaded as shown in drawing 11 (b), it does not come to form a superfluous carrier layer. Therefore, the carrier temporarily captured on the front face does not overcome an obstruction, either, carries out it, and it does not serve as the

dark current, and the noise component from a front face can be controlled.

[0063] A read-out period is a period which reads the video signal (Vout) based on the accumulated optical generating charge. MOS transistor 112 for lightwave signal detection is operated as a source follower circuit, and a video signal (Vout) is outputted. In this case, while impressing an about [+2-3V] electrical potential difference to the drain of MOS transistor 112 about for every line by the VDD supply lines 22a and 22b so that MOS transistor 112 may operate by the saturation state, an about [+2-3V] electrical potential difference is about impressed to the gate of MOS transistor 112 for every train by the VSCAN supply lines 21a and 21b. Furthermore, a constant current source 106 is connected to the source of MOS transistor 112 for lightwave signal detection, and a fixed current is passed.

[0064] By the way, the optical generating charge is accumulated into the carrier pocket 25 in the are recording period in front of this read-out period. If an optical generating charge is accumulated into the carrier pocket 25, a Fermi level changes according to an accumulated dose, and space charge will bring about the fall of the threshold voltage of a transistor in order to decrease in number. A reversal field is formed on the carrier pocket 25 of the conservation of charge at

coincidence, the electron of the same amount as the amount of the optical generating hole accumulated into the carrier pocket 25 in the reversal field increases, and channel conductance increases.

[0065] In this case, the surface potential on the carrier pocket 25 serves as about 1 constant value in the direction of gate length, and the electron which is a carrier is distributed over a reversal field by the uniform consistency. On the other hand, in the drain diffusion field 17a side, since space charge density is low, it is not generated on a front face but a high electric-field field produces a reversal field on it. Thus, since the reversal field was generated to a part of channel field and the high electric-field field is generated into other parts, as shown in drawing 10 , actuation of MOS transistor 112 for lightwave signal detection by the saturation state is attained.

[0066] Therefore, if the usual operating voltage is impressed to each electrode of MOS transistor 112 for lightwave signal detection, a transistor 112 will operate by the saturation state. Since the transistor 112 forms the source follower circuit by constant current actuation at this time, as shown in drawing 9 (a) and (b), source potential becomes high, in order to decrease the potential difference between the gate-sources so that a fixed current may flow to a transistor 112

according to a negative feedback operation. Change of this source potential is outputted to the video-signal output 107.

[0067] In addition, the above-mentioned read-out actuation may be understood as follows. That is, as shown in drawing 10 , in order that MOS transistor 112 for lightwave signal detection may operate in a saturation region, the potential difference between the drain-sources is determined by the potential under the gate electrode 19, and the electric field of source diffusion field 16 direction exist in the well field 15 of p mold according to the potential difference.

[0068] Therefore, although an optical generating hole changes the Fermi potential of the source diffusion field 16 neighborhood to a positive direction, since the current value is determined by the constant current source 106, the potential barrier height by the side of the source is saved. For this reason, as shown in drawing 9 (a) and (b), in source potential (VS), the change for the potential difference of the space charge layer carbonated by impregnation of an optical generating hole appears. That is, bulk potential can be changed with the amount of optical generating holes, and a source follower output can be changed.

[0069] Thereby, the video signal (Vout) proportional to an optical exposure can

be acquired. In this case, since a fluctuated part of the charge of an optical generating hole and a reversal field is balanced, the amount of charges by the optical generating hole is equivalent to the charge to gate-dielectric-film 18 capacity, and a changed part of threshold voltage is outputted. Here, as shown in drawing 12 (a) and (b), since the charge to gate-dielectric-film 18 capacity is limited to gate-dielectric-film 18 capacity on the carrier pocket 25, it can determine detection sensitivity with the area and the depth of gate oxidation thickness and the carrier pocket 25. Moreover, since an optical generating hole is accumulated in a limited field called the carrier pocket 25, conversion efficiency is also good.

[0070] And since it can consider that most of this detection capacity is fixed capacity, the high sensitivity detection which was extremely excellent in the linearity of the transfer characteristics of charge-electrical-potential-difference conversion is attained. Next, according to drawing 6 (a) and (b), photodetection actuation of the solid state image sensor with which a single string continued is explained briefly. namely, initialization actuation -- a well -- the charge which remains in the semi-conductor layer of a field or others is discharged.

[0071] Subsequently, low gate voltage is impressed to the gate electrode 19 of a

transistor, and the electrical potential difference (VDD) of the abbreviation 2-3V required for actuation of a transistor is impressed to drain diffusion field 17a. this time -- a well -- a field 15 is depletion-ized and the electric field which go to the source diffusion field 16 produce it from drain diffusion field 17a. If an electronic-hole pair (optical generating charge) arises by optical exposure, an optical generating hole will be poured into a gate field among this optical generating charge by the above-mentioned electric field, and it will be accumulated in the carrier pocket 25. While the depletion-layer width of face which spreads in a substrate 11 side from a channel field is restricted by this, the potential of the source diffusion field 16 neighborhood is modulated, and the threshold voltage of MOS transistor 112 is changed.

[0072] Here, the gate voltage of the abbreviation 2-3V to which MOS transistor 112 can operate by the saturation state is impressed to the gate electrode 19, and the electrical potential difference VDD which are the abbreviation 2-3V to which MOS transistor 112 can operate to drain diffusion field 17a is impressed. Thereby, the reversal field of low electric field is formed in a part of channel field, and a high electric-field field is formed in the remaining part.

[0073] Furthermore, a constant current source 106 is connected to the source

diffusion field 16 of MOS transistor 112, and a fixed current is passed. Thereby, a source follower circuit is formed, therefore it follows in footsteps of fluctuation of the threshold voltage of the MOS transistor by the optical generating hole, source potential changes, and MOS transistor 112 brings about change of output voltage. Thereby, the video signal (Vout) proportional to an optical exposure can be taken out.

[0074] As mentioned above, according to the gestalt of implementation of this invention, in a series of processes of ******** (initialization)-are recording actuation-read-out actuation, when an optical generating hole moves, the ideal photo-electric-conversion device which does not interact with the noise source in a semi-conductor front face or a channel field can be realized. Moreover, since [under a channel field] the part is prepared in the field, a part of channel field can be made into a reversal field for the carrier pocket 25, and the remaining part can be made into a high electric-field field. Thereby, as shown in drawing 10 , a transistor can be operated by the saturation state. And since the source follower circuit is formed, change of the threshold voltage by the optical generating charge is detectable as change of source potential. For this reason, photo electric conversion with sufficient linearity can be performed.

[0075] In addition, in the case of the BCMD mold solid state image sensor of the conventional example shown in drawing 13 (b), the current-voltage characteristic turns into a triode property and actuation by the saturation state is difficult for it. For this reason, it can be said that it is difficult to perform photo electric conversion with sufficient linearity. Furthermore, since the light-receiving diode 111 and MOS transistor 112 for lightwave signal detection are formed separately, degradation of the spectral sensitivity characteristic by multiplex interference like the optical exposure to a photograph gate electrode can be prevented.

[0076] Moreover, since a component configuration can be performed in the simple combination of the light-receiving diode 111 and MOS transistor 112 for lightwave signal detection, a numerical aperture can be improved. Furthermore, gate voltage can be changed and a fixed pattern noise can be controlled taking advantage of the property that the gain and source capacity of a source follower can be adjusted. in addition -- the gestalt of the above-mentioned implementation -- the well of p mold -- a field 15 -- p+ although the carrier pocket 25 of a mold was formed, the hole was accumulated and the nMOS transistor (MOS transistor for lightwave signal detection) 112 has detected the lightwave signal -- the well of n mold -- a field -- using -- n+ The carrier pocket of a mold is

prepared, an electron is accumulated and you may make it a pMOS transistor (MOS transistor for lightwave signal detection) detect a lightwave signal.

[0077] Moreover, he is trying to impress the electrical potential difference of abbreviation +5V which were made to flow through a channel field and were impressed to drain diffusion field 17a to the source diffusion field 16 as it is in drawing 6 (a) which shows the configuration of the whole solid state image sensor by impressing the electrical potential difference of abbreviation +5V to the gate electrode 19 in a **** period. However, a power source with which only a **** period supplies the electrical potential difference of abbreviation +5V to the source diffusion field 16 through a switch means may be independently connected to the source diffusion field 16.

[0078] Furthermore, in drawing 6 (a) which shows the configuration of the above-mentioned whole solid state image sensor, although the constant current source is used as a load circuit, volume load may be used. In this case, if the source potential of the transistor 112 for lightwave signal detection changes with are recording of an optical generating charge, since capacity will be charged by that change, that charge electrical potential difference can be taken out as a video signal. Moreover, it is possible to use the load circuit of others which have

a high impedance which forms the source follower other than a constant current source or volume load.

[0079]

[Effect of the Invention] as mentioned above, the solid state image sensor of the threshold voltage modulation technique concerning this invention -- setting -- a well -- the light-receiving diode and the insulated gate field effect transistor which share a field -- having -- and the well under the channel field of a transistor -- it has the high concentration buried layer (carrier pocket) near the source diffusion field in a field.

[0080] For this reason, the interior of a semi-conductor can be moved, the optical generating charge generated in the light-receiving diode section can be stored up in a high concentration buried layer, and the threshold voltage of a transistor can be changed. Therefore, thermal noise (kTC noise), a semi-conductor surface capture noise, etc. can be controlled until it results in **** (initialization) of residual charge, photo electric conversion, are recording, and electrical-potential-difference conversion. Thereby, the solid state image sensor of a low noise can be offered, and the engine performance of MOS mold image sensors can be improved beyond the engine performance of CCD mold image

sensors.

[0081] Moreover, since [under a channel field] the part is prepared in the field, a part of channel field can be made into a reversal field for a high concentration buried layer, and the remaining part can be made into a high electric-field field. Thereby, a transistor can be operated by the saturation state. And since the source follower circuit which connected the load circuit of a high impedance represented with a constant current drive is formed, change of the threshold voltage by the optical generating charge is detectable as change of source potential. For this reason, photo electric conversion with sufficient linearity can be performed.

[0082] Furthermore, since a component configuration can be performed in the simple combination of light-receiving diode and the MOS transistor for lightwave signal detection, a numerical aperture can be improved. Moreover, gate voltage can be changed and a fixed pattern noise can be controlled taking advantage of the property that the gain and source capacity of a source follower can be adjusted. Furthermore, with the existing CMOS process technique, since manufacture of a light sensing portion is possible, a circumference circuit can also be created to the same substrate very cheaply.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the top view showing the component layout in the unit pixel of the solid state image sensor concerning the gestalt of operation of this invention.

[Drawing 2] It is the A-A line sectional view of drawing 1 showing the structure of the component in the unit pixel of the solid state image sensor concerning the gestalt of operation of this invention.

[Drawing 3] It is the sectional view showing the carrier pocket in the unit pixel of the solid state image sensor concerning the gestalt of operation of this invention, and the detail of the periphery.

[Drawing 4] It is the B-B line sectional view of drawing 1 showing the structure of the light-receiving diode in the unit pixel of the solid state image sensor concerning the gestalt of operation of this invention.

[Drawing 5] It is the C-C line sectional view of drawing 1 showing the structure of the MOS transistor for lightwave signal detection in the unit pixel of the solid state image sensor concerning the gestalt of operation of this invention.

[Drawing 6] Drawing 6 (a) is drawing showing the circuitry of the whole solid state image sensor concerning the gestalt of operation of this invention. Drawing 6 (b) is a timing chart at the time of operating the solid state image sensor of drawing 6 (a).

[Drawing 7] Drawing 7 (a) is drawing in the condition that there is a **** period at the time of actuation of the solid state image sensor concerning the gestalt of

operation of this invention showing the potential distribution in D-D line cross section of drawing 4 . Drawing 7 (b) is drawing in the condition that there is a **** period at the time of actuation of the solid state image sensor concerning the gestalt of operation of this invention showing the potential distribution in the E-E line cross section of drawing 5 .

[Drawing 8] Drawing 8 (a) is drawing in the condition that there is an are recording period at the time of actuation of the solid state image sensor concerning the gestalt of operation of this invention showing the potential distribution in D-D line cross section of drawing 4 . Drawing 8 (b) is drawing in the condition that there is an are recording period at the time of actuation of the solid state image sensor concerning the gestalt of operation of this invention showing the potential distribution in the E-E line cross section of drawing 5 .

[Drawing 9] Drawing 9 (a) is drawing in the condition that there is a read-out period at the time of actuation of the solid state image sensor concerning the gestalt of operation of this invention showing the potential distribution in D-D line cross section of drawing 4 . Drawing 9 (b) is drawing in the condition that there is a read-out period at the time of actuation of the solid state image sensor concerning the gestalt of operation of this invention showing the potential

distribution in the E-E line cross section of drawing 5 .

[Drawing 10] It is the graph which shows the current-voltage characteristic of the MOS transistor for lightwave signal detection in the unit pixel of the solid state image sensor concerning the gestalt of operation of this invention.

[Drawing 11] Drawing 11 (a) is drawing showing the condition of the channel layer front face after charge reset of a solid state image sensor, drawing 11 (b) is drawing showing the condition of the channel layer front face of the solid state image sensor concerning the gestalt of operation of this invention, and drawing 11 (c) is drawing showing the condition of the channel layer front face of the solid state image sensor of the photograph gate structure concerning the conventional example.

[Drawing 12] Drawing 12 (a) is drawing showing the distribution condition of the charge which lasts to a read-out period from the are recording period at the time of actuation of the solid state image sensor concerning the gestalt of operation of this invention. Drawing 12 (b) is a carrier pocket for explaining drawing 12 (a), and the component sectional view of the neighborhood.

[Drawing 13] Drawing 13 (a) is the sectional view showing the structure of the solid state image sensor of the BCMD structure concerning the conventional

example. Drawing 13 (b) is a graph which shows the current-voltage characteristic of the solid state image sensor of the BCMD structure concerning the conventional example.

[Description of Notations]

15 Well -- Field,

15a n mold impurity layer (impurity layer of an opposite conductivity type),

16 16a Source diffusion field,

17 Impurity Diffusion Field,

17a Drain diffusion field,

19 Gate Electrode,

20, 20a, 20b Perpendicular output line,

21, 21a, 21b Vertical-scanning signal (VSCAN) supply line,

22, 22a, 22b Drain electrical-potential-difference (VDD) supply line,

25 Carrier Pocket (High Concentration Buried Layer),

26 Water Hiraide Line of Force,

27a, 27b Horizontal scanning signal (HSCAN) supply line,

28a, 29a Photodetection signal input terminal,

28b, 29b Horizontal scanning signal input terminal,

28c, 29c Photodetection signal output terminal,

101 Unit Pixel,

102 Vertical-Scanning Signal (VSCAN) Drive Scanning Circuit,

103 Drain Electrical-Potential-Difference (VDD) Drive Scanning Circuit,

104 Horizontal Scanning Signal (HSCAN) Drive Scanning Circuit,

105a, 105b Switch,

106 Constant Current Source (Load Circuit),

111 Light-receiving Diode,

112,112a MOS transistor for lightwave signal detection.